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Self-assessment of tooth discoloration on natural anterior teeth between different types of smoking among adults in Riyadh, Saudi Arabia

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ABSTRACT

Objectives: The aim of the study is to evaluate anterior teeth staining caused by different types of smoking. **Methodology:** Questionnaire was prepared to have the following sections: Sociodemographic, oral hygiene practices, smoking habits and evaluation of teeth staining. The questionnaire and dental staining evaluation were conducted as follows. Pictures with different severities of staining were provided in the questionnaire, and it will be used by the participant to conclude the severity of their stains. In regard to stains, it will be classified as follows: no-stains, mild, moderate and severe. In addition, the questionnaire will contain four pictures with varying levels of stains coverage. **Results:** A total 465 participants from different demographical backgrounds who all met intended criteria. The study shows the participants who smoked any of the following traditional cigarettes, electronic cigarettes and hookah had high staining on their anterior teeth. In addition, respondents with poor oral hygiene had worse tooth stain score compared to those who had good oral hygiene. **Conclusion:** From our research we can conclude that smoking any of following traditional cigarettes, electronic cigarettes or hookah can cause tooth staining. This is usually worsened by the poor of oral hygiene which as indicated by our research.

Keywords: Teeth staining, Teeth discoloration, Smoking, Cigarettes, Electronic cigarettes, Shisha, E-cigarettes, Hookah.

1. INTRODUCTION

Tooth discoloration is defined as any change in the color, hue or translucency of a tooth due to multiple causes and it is one of the most common complaint in dentistry (Alkhatib et al., 2005). Tooth discoloration is considered a major



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concern in dentistry, primarily due to its negative psychological effect, as it may affect the self-esteem of individuals with teeth staining (Newton et al., 2003). The topic of tooth discoloration is not a foreign area in the field of medical research (Sulieman, 2005). Tooth discoloration is usually classified into either intrinsic or extrinsic stain, based on the etiological factors (Sulieman, 2005). Intrinsic discolorations are associated with factors such as developmental anomalies, pulp pathology, while extrinsic stain usually caused by dietary factors and tobacco products (Sulieman, 2005). poor oral hygiene, medications, dental materials, and trauma also can cause tooth discoloration (Alkhatib et al., 2005). Smoking is considered a major risk factor for general health. Smoking can negatively affect the oral cavity by several ways, as it can cause oral cancer, periodontal disease, and tooth loss (Sulieman, 2005). Tooth discoloration is considered the most visible manifestation of smoking (Sulieman, 2005). Tobacco stain might be yellow, brown, dark brown or black stains, the severity depends on the duration and frequency of smoking (Sulieman, 2005). According to a recent national survey in the United Kingdom, the risk of severe tooth discoloration in smokers is 2.4 times higher than nonsmokers (Alkhatib et al., 2005). Electronic cigarettes are devices that deliver nicotine as an alternative to standard tobacco products (Pintado-Palomino et al., 2019). The use of E-cigarettes has been increased in the last few years, mainly due to claims of their safety. Some studies have shown that E-cigarettes provide less harmful effect than conventional cigarettes. The effect of E-cigarettes on dental tissues, especially regarding color change, has not yet been demonstrated well (Pintado-Palomino et al., 2019). Waterpipes are known also as shisha are becoming increasingly common. Hookah smoking has not been studied well as cigarette smoking in its effect on dental health (Shah et al., 2013). All in all, the topic of tooth discoloration is important due to its effect on the physical, emotional, and social well being (Sulieman, 2005).

2. METHODOLOGY

The study is going to be conducted using administered questionnaires. Questionnaires are going to be prepared to have the following sections: first, Sociodemographic data: including age, gender. Second, oral hygiene practices. The questionnaire and dental staining evaluation is going to be conducted as follows. The questionnaire will contain four pictures with varying levels of stains. The first picture will contain (less than 24% of the tooth surface), the second picture contains mild (25-49% of the tooth surface), the third picture is moderate (50-74% of the tooth surface), and the last one is severe stains (more than 75% of the tooth surface). The stain pictures that provided in the questionnaire will be used by the participant to conclude the severity of their stains. We will divide the participants into four groups dependent on the answers which are (non- staining, mild, moderate, and severe). Afterwards based on the severity they will be divided in regard to the color of the stains. It will be as follows: no-stains, moderate, severe.

Our study Participants must meet the following three conditions: smoker of cigarettes, E-cigarettes and shisha smokers or non-smoker, all upper and lower anterior natural teeth present, ability to fill self-reporting survey, ability to fill survey in Arabic. Participants with any of the following points will be excluded: anterior teeth restorations, scaling and/or bleaching in the past 6 months, medication that cause staining and orthodontic brackets. The collection of the data was done between March 2020 and August 2021. The collected data were entered and analyzed using the SPSS statistical program. Statistical analysis, including the following: descriptive statistics including number, means, and percentage. Independent Samples T-Test, Levene's test, Tukey Post-hoc test, One-way ANOVA test, and Games-Howell Post-hoc test to compare the results.

3. RESULT

Table 1 shows the smoking pattern among the participants based on gender. It reveals that the majority of smokers are males. Table 2 shows that majority of the respondents who are less than 20 years of age (79%) are non-smokers. Similarly, majority of the respondents who are more than 41 years of age (55%) are also non-smokers. On the other hand, majority of the people who are 21 to 40 years of age are regular smokers. Majority of all age groups except 41+ years of age are non-smokers of traditional cigarettes. 54% of the regular smokers of traditional cigarettes were more than 31 years of age. Most of the age groups are non-smokers of electronic cigarettes. Almost, 68% of the regular smokers of electronic cigarettes are 21-30 years of age. Around 56% of the regular Hookah smokers are also 21-30 years of age. Nearly, 17% of the traditional cigarette smokers who are 21-30 years of age smoke 10-20 cigarettes per day. Approximately 20% of the traditional smokers who are 31-40 years old also smoke 10-20 cigarettes per day. Approximately 42% of the respondents who smoke hookah more than twice a week are 21-30 years old. Approximately 70% of the electronic cigarette smokers who use it daily are also 21-30 years old. 70% of the respondents who are 21-30 years of age started smoking less than 5 years ago.

Table 1 Smoking and Gender

	Gender			
	Male		Female	
	<i>f</i>	%	<i>f</i>	%
Do you smoke any of the following (traditional cigarette, electronic cigarette, hookah) currently?				
Yes, regularly	113	48.90%	35	26.90%
Yes, intermittently	23	10.00%	17	13.10%
No	95	41.10%	78	60.00%
Traditional cigarette				
Non-Smoker	82	44.30%	38	64.40%
Regular	65	35.10%	9	15.30%
Social	19	10.30%	6	10.20%
Ex-smoker	19	10.30%	6	10.20%
Electronic cigarette				
Non-Smoker	113	62.10%	27	42.90%
Regular	57	31.30%	29	46.00%
Social	9	4.90%	4	6.30%
Ex-smoker	3	1.60%	3	4.80%
Hookah				
Non-Smoker	83	45.60%	27	44.30%
Regular	43	23.60%	13	21.30%
Social	32	17.60%	13	21.30%
Ex-smoker	24	13.20%	8	13.10%
What's the total number of years since you started smoking?				
Less than 5 years	66	40.50%	38	69.10%
5 to 10 years	35	21.50%	14	25.50%
11 to 14 years	24	14.70%	2	3.60%
More than 15 years	38	23.30%	1	1.80%
If you use traditional cigarette, how many cigarettes do you smoke per day?				
Non smoker	79	50.00%	41	70.70%
Less than 10 traditional cigarettes	24	15.20%	10	17.20%
10 to 20 traditional cigarettes	35	22.20%	6	10.30%
21 to 30 traditional cigarettes	15	9.50%	1	1.70%
31 to 40 traditional cigarettes	5	3.20%	0	0.00%
If you use hookah, how many times in a week do you use it?				
More than twice (specify)	36	22.90%	9	15.50%
Non-smoker	77	49.00%	34	58.60%
Once	20	12.70%	8	13.80%
Twice	24	15.30%	7	12.10%
If you use electronic cigarette how often do you use it?				
Non-smoker	84	54.90%	18	32.10%
Daily	58	37.90%	29	51.80%
Not daily, but at least once a week	6	3.90%	5	8.90%
Not weekly, but at least once a month	5	3.30%	4	7.10%

Table 2: Smoking and Age

Variable	Age (years)							
	< =20		21 - 30		31 - 40		41+	
	f	%	f	%	f	%	f	%
Do you smoke any of the following (traditional cigarette, electronic cigarette, hookah) currently?								
Yes, regularly	6	11%	76	49%	39	53%	27	36%
Yes, intermittently	6	11%	20	13%	7	10%	7	9%
No	44	79%	60	39%	28	38%	41	55%
Traditional cigarette								
Non-Smoker	14	61%	72	56%	23	43%	9	25%
Regular	5	22%	29	23%	19	35%	21	58%
Social	4	17%	16	12%	2	4%	3	8%
Ex-smoker	0	0%	12	9%	10	19%	3	8%
Electronic cigarette								
Non-Smoker	15	68%	64	49%	30	55%	30	88%
Regular	2	9%	58	44%	21	38%	4	12%
Social	4	18%	6	5%	3	6%	0	0%
Ex-smoker	1	5%	4	3%	1	2%	0	0%
Hookah								
Non-Smoker	14	67%	58	44%	23	43%	14	39%
Regular	1	5%	32	24%	12	23%	11	31%
Social	3	14%	25	19%	11	21%	6	17%
Ex-smoker	3	14%	16	12%	7	13%	5	14%
What's the total number of years since you started smoking ?								
Less than 5 years	9	64%	82	70%	12	24%	0	0%
5 to 10 years	5	36%	27	23%	14	28%	3	9%
11 to 14 years	0	0%	6	5%	13	26%	7	20%
More than 15 years	0	0%	2	2%	12	24%	25	71%
If you use traditional cigarette, how many cigarettes do you smoke per day?								
Non smoker	8	47%	67	59%	30	59%	15	43%
Less than 10 traditional cigarettes	5	29%	23	20%	3	6%	3	9%
10 to 20 traditional cigarettes	4	24%	19	17%	10	20%	8	23%
21 to 30 traditional cigarettes	0	0%	4	4%	4	8%	8	23%
31 to 40 traditional cigarettes	0	0%	0	0%	4	8%	1	3%
If you use hookah, how many times in a week do you use it?								
More than twice (specify)	1	7%	19	17%	14	28%	11	31%
Non smoker	11	73%	55	49%	28	55%	17	49%
Once	1	7%	18	16%	5	10%	3	9%
Twice	2	13%	21	19%	4	8%	4	11%
If you use electronic cigarette how often do you use it?								
Non smoker	8	53%	39	36%	25	50%	30	88%
Daily	2	13%	60	55%	20	40%	4	12%
Not daily, but at least once a week	4	27%	4	4%	3	6%	0	0%

Not weekly, but at least once a month	1	7%	6	6%	2	4%	0	0%
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Table 3 shows that those who smoke any of traditional cigarette, electronic cigarette or hookah regularly have the highest mean score for U-Tooth, UP-Tooth, L-Tooth and LP-Tooth compared to those who intermittently smoke these or don't smoke any of these. Table 4 indicates that Ex-smokers of traditional cigarettes have the highest mean score for U-Tooth and L-Tooth. Whereas regular smokers of traditional cigarettes; have the highest mean score for UP-Tooth and LP-Tooth. Regular smokers of electronic cigarettes have the highest mean score for U-Tooth and L-Tooth. However social smokers of electronic cigarettes have the highest mean scores for UP-Tooth and LP-Tooth. Ex-smokers of hookah had the highest mean scores for U-Tooth, UP-Tooth, L-Tooth and LP-Tooth. Regular hookah smokers had the second-highest mean score for all 4 variables related to hookah.

Table 3: Mean Tooth Staining Scores Based on Smoking Habit

	U-Tooth		UP-Tooth		L-Tooth		LP-Tooth	
Do you smoke any of the following (traditional cigarette, electronic cigarette, hookah) currently?	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Yes, regularly	12.80	5.34	9.50	3.72	12.70	5.27	9.60	4.11
Yes, intermittently	10.40	3.29	8.40	3.62	9.90	3.53	8.40	3.83
No	9.80	3.72	8.40	4.30	10.10	3.67	9.10	4.69

Note: U-Tooth indicates upper teeth staining, UP-Tooth indicates upper teeth staining coverage, L-Tooth indicates lower teeth staining, LP-Tooth indicates lower teeth staining coverage

Table 4: Mean Tooth Staining Score Based on Smoking Types

	U-Tooth		UP-Tooth		L-Tooth		LP-Tooth	
Traditional cigarette	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Non-Smoker	10.30	4.16	8.10	3.63	10.20	4.51	8.40	4.03
Regular	12.60	5.38	10.30	4.93	12.80	5.29	10.50	4.56
Social	10.40	4.38	8.20	3.02	9.80	4.13	8.40	3.64
Ex-smoker	15.80	5.29	9.90	3.41	14.80	5.42	9.10	2.77
	U-Tooth		UP-Tooth		L-Tooth		LP-Tooth	
Electronic cigarette	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Non-Smoker	11.20	4.75	8.70	3.88	11.30	5.02	9.10	4.05
Regular	12.20	5.33	9.00	3.82	11.90	5.20	8.70	3.85
Social	11.30	4.68	9.60	5.53	10.50	4.31	10.20	5.46
Ex-smoker	9.70	3.72	9.30	7.23	8.50	4.81	9.80	7.22
	U-Tooth		UP-Tooth		L-Tooth		LP-Tooth	
Hookah	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Non-Smoker	10.40	4.37	8.00	3.39	10.40	4.75	8.30	3.65
Regular	11.80	5.10	9.30	4.08	11.60	5.12	9.90	4.45
Social	11.50	4.64	8.50	3.71	11.20	4.50	8.40	3.47
Ex-smoker	14.90	5.97	11.50	5.29	14.30	6.00	10.80	5.40

Table 5 indicate that those who were smoking for more than 15 years have the highest mean score for U-Tooth, UP-Tooth, L-Tooth and LP-Tooth. Table 6 suggest that those who smoke 21-30 traditional cigarettes per day had the highest mean scores for U-

Tooth, UP-Tooth, L-Tooth and LP-Tooth. Those who smoke hookah more than twice a week and those who smoke it once a week had the highest mean score for U-Tooth. Participant's hose who smoke Hookah once a week also had the highest mean score for UP-Tooth, L-Tooth and LP-Tooth. Those who smoke electronic cigarettes daily had the highest mean score for U-Tooth. Those who smoke electronic cigarettes once a week had the highest mean scores for UP-Tooth and LP-Tooth. Non-smokers of electronic cigarettes have the highest mean score for L-Tooth.

Table 5: Mean Tooth Staining Scores Based on Years Being Smokers

	U-Tooth		UP-Tooth		L-Tooth		LP-Tooth	
What's the total number of years since you started smoking?	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Less than 5 years	9.70	3.45	7.60	3.06	9.50	3.55	7.60	3.20
5 to 10 years	12.60	5.43	9.50	3.74	12.10	5.03	9.10	3.30
11 to 14 years	13.00	4.25	10.80	4.91	12.80	4.53	10.50	4.51
More than 15 years	15.80	5.58	11.70	5.08	15.60	5.67	12.10	4.84

Table 6: Mean Tooth Staining Scores Based on Smoking Frequency

	U-Tooth		UP-Tooth		L-Tooth		LP-Tooth	
How many traditional cigarettes do you smoke per day?	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Non-smoker	11.70	4.95	8.80	3.76	11.50	4.83	8.60	3.71
Less than 10 traditional cigarettes	10.00	3.78	8.40	3.42	9.10	3.44	7.90	2.64
10 to 20 traditional cigarettes	12.30	4.99	10.00	4.69	12.30	5.03	10.20	4.33
21 to 30 traditional cigarettes	15.90	5.43	12.40	5.97	16.50	5.13	13.40	5.68
31 to 40 traditional cigarettes	11.80	7.01	6.60	0.89	12.00	7.04	8.20	3.03
How many times in a week do you use Hookah?	U-Tooth		UP-Tooth		L-Tooth		LP-Tooth	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
More than twice	12.20	5.30	9.40	3.93	11.90	5.07	9.90	4.39
Non-smoker	11.90	5.22	8.90	3.73	11.80	5.18	8.70	3.64
Once	12.20	4.98	10.60	5.38	12.60	5.43	10.30	5.10
Twice	10.50	3.93	8.20	4.40	9.80	3.76	8.40	4.20
How often do you use Electronic Cigarette?	U-Tooth		UP-Tooth		L-Tooth		LP-Tooth	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Non-smoker	12.00	4.92	9.10	3.96	12.00	4.99	9.40	4.00
Daily	12.30	5.26	9.00	3.78	11.90	5.17	8.80	3.83
Not daily, but at least once a week	10.80	5.00	10.10	6.49	10.50	4.48	10.10	6.14
Not weekly, but at least once a month	9.00	3.08	8.90	4.26	8.40	2.96	8.40	3.28

Table 7: Independent Samples T-Test between Gender and Mean Tooth Staining Scores

Variable	Gender						
	Male		Female				
	M	SD	M	SD	t	df	p-value
U-Tooth	11.62	4.73	8.96	3.65	6.732	408	<.001
UP-Tooth	9.25	4.42	7.47	3.27	4.936	420	<.001
L-Tooth	11.42	4.78	9.48	3.73	4.499	463	<.001
LP-Tooth	9.54	4.64	7.82	3.46	4.544	418	<.001

Table 7 present Independent samples t-tests were performed to find out if there is a significant difference in mean score for the 4 dependent variables based on gender. Adjustments to degrees of freedom were made where Levene's test for equality of variance was significant. The results show that males have a significantly higher score for U-Tooth, UP-Tooth, L-Tooth and LP-Tooth compared to females. All the tests for gender shown in table 7 were significant at 95% confidence interval ($p < .001$).

Table 8 ANOVA between Age and U-Tooth

AGE	N	M	SD	F (3,458)	p-value
<=20	85	9.13	3.50	18.080	<.001
21 to 30	212	9.90	4.04		
31-40	87	11.89	4.86		
41+	78	13.35	5.17		
Total	462	10.71	4.56		

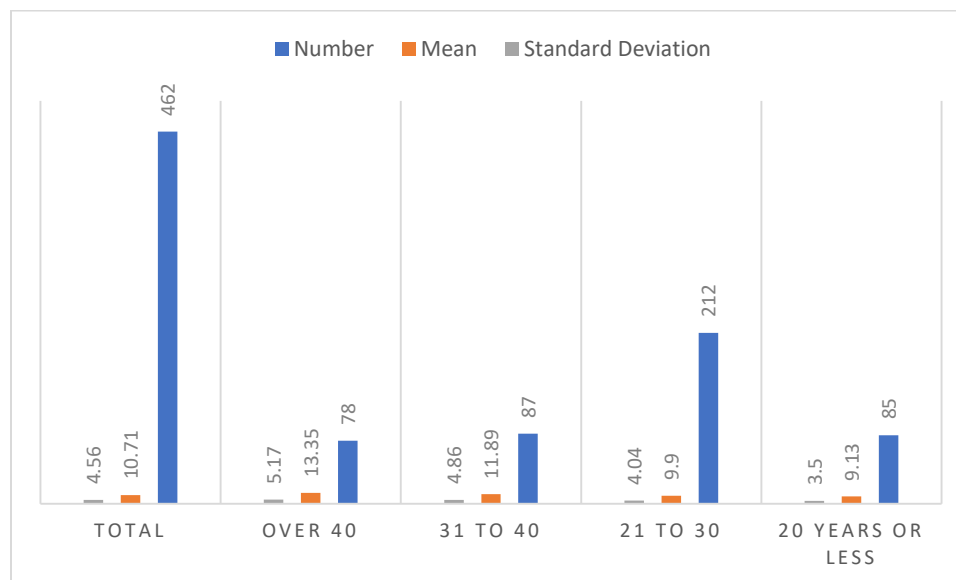


Figure 1 Age and U-Tooth

Table 8 and figure 1 shows One-way ANOVA was performed to find out if there is a significant difference in U-Tooth score between different age groups ($F(3,458) = 18.080$, $p < .001$). Levene's test for equality of variance was not significant ($p > .05$). Table 9 shows One-way ANOVA test between age and UP-Tooth was significant ($F(3,458) = 5.282$, $p < .01$). Levene's test for equality of variance was not significant. Table 10 and figure 2 indicates that there is a significant difference in LP-Tooth scores across age groups ($F(3,190) = 13.683$, $p < .001$). Levene's test for equality of variance was significant ($p < .05$). Therefore, adjustments to degrees of freedom were made and Games-Howell post-hoc test was performed to assess the pairwise comparison of L-Tooth scores between age groups.

Table 9 ANOVA between Age and UP-Tooth

AGE	N	M	SD	F (3,458)	p-value
<=20	85	7.92	3.59	5.282	<.01
21 to 30	212	8.16	3.91		
31-40	87	9.44	4.27		
41+	78	9.86	4.82		
Total	462	8.64	4.15		

Table 10 ANOVA between Age and L-Tooth

AGE	N	M	SD	F (3,190)	p-value
<=20	85	9.48	3.24	13.683	<.001
21 to 30	212	9.90	4.11		
31-40	87	11.86	4.64		
41+	78	13.32	5.41		
Total	462	10.77	4.53		

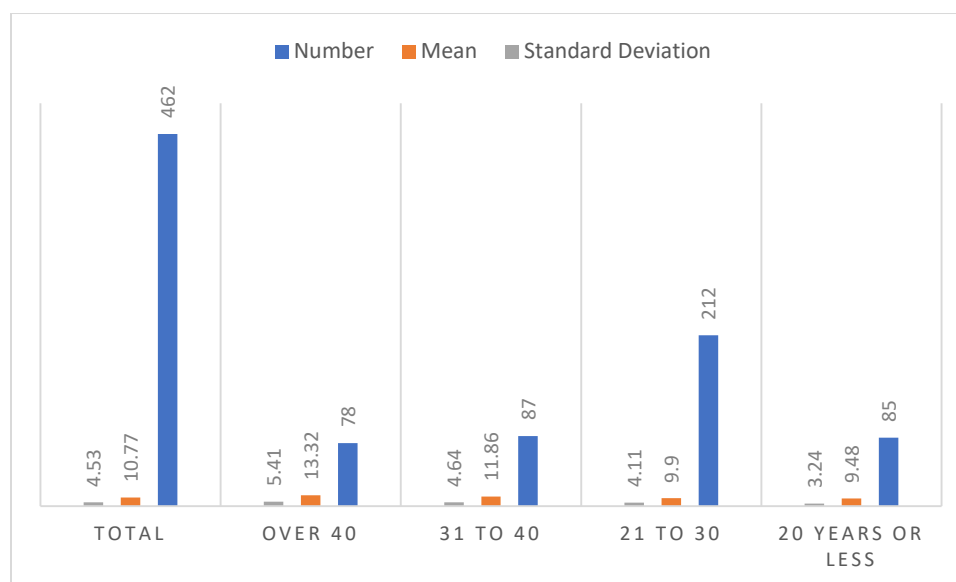
**Figure 2** Age and L-Tooth

Table 11 shows that respondents who are less than 20 years of age had a significantly lower L-Tooth score than respondents who are 31-40 years ($p < .01$) and those who are 41+ years of age ($p < .001$). Respondents who are 21-30 years of age also had a significantly lower L-Tooth score ($M = 9.90$, $SD = 4.11$) than those who are 31-40 years old ($p < .01$) and those who are 41+ years of age ($p < .001$). All other pairwise comparisons are not significant. Table 12 indicated that there is a significant difference in LP-Tooth scores across age groups as ANOVA is significant ($F(3,183) = 4.342$, $p < .01$). Adjustments to degrees of freedom have to be made as Levene's test for equality of variance was also significant ($p < .05$). Therefore, Games-Howell post-hoc pairwise comparisons were tested.

Table 11 Games-Howell Post-hoc test between age groups and L-Tooth scores

(I) Age group	(J) Age group	Mean Difference (I-J)	Std. Error	Sig.
<=20	21 to 30	-0.42	0.45	0.79
	31-40	-2.38	0.61	<.01
	41+	-3.84	0.71	<.001

21 to 30	31-40	-1.96	0.57	<.01
	41+	-3.42	0.67	<.001
31-40	41+	-1.46	0.79	0.255

Table 12 ANOVA between Age and LP-Tooth

AGE	N	M	SD	F (3,183)	p-value
<=20	85	8.79	4.47	4.342	<.01
21 to 30	212	8.30	3.90		
31-40	87	9.54	4.49		
41+	78	10.28	4.85		
Total	462	8.96	4.34		

Table 13 show that only one pairwise comparison differs significantly from each other and all other pairwise comparisons are not significant at 95% confidence interval. Respondents who are 21 to 30 years of age had a significantly lower LP-Tooth score than those who were 41+ years of age. Table 14, 15 and figure 3 shows One-way ANOVA between oral hygiene condition and U-Tooth score is significant ($F(2,434) = 23.226, p < .001$). Those who said they don't know about their oral hygiene condition were excluded from the analysis. Levene's test for equality of variance was not significant ($p > .05$). Therefore, Tukey HSD post-hoc comparisons were done. Those who had Bad oral hygiene had a significantly higher U-Tooth score, than those who had good oral hygiene ($p < .001$) and those who had excellent oral hygiene ($p < .001$).

Table 13 Games-Howell Post-hoc test between age groups and LP-Tooth scores

(I) Age group	(J) Age group	Mean Difference (I-J)	Std. Error	Sig.
<=20	21 to 30	0.49	0.55	0.812
	31-40	-0.75	0.68	0.69
	41+	-1.49	0.73	0.178
21 to 30	31-40	-1.24	0.55	0.114
	41+	-1.98	0.61	<.01
31-40	41+	-0.74	0.73	0.741

Table 14 ANOVA between Oral Hygiene and U-Tooth

Oral Hygiene	N	M	SD	F (2,434)	p-value
Excellent	108	9.31	4.22	23.226	<.001
Good	276	10.36	4.17		
Bad	53	14.13	5.03		
Total	437	10.56	4.51		

Table 15 Tukey HSD Post-hoc test between Oral Hygiene and U-Tooth scores

(I) Oral Hygiene?	(J) Oral Hygiene?	Mean Difference (I-J)	Std. Error	Sig.
Excellent	Good	-1.05	0.49	0.079
	Bad	-4.83	0.72	<.001
Good	Bad	-3.77	0.64	<.001

Table 16 and 17 shows that ANOVA is significant which indicates that there is a significant difference in UP-Tooth scores based on oral hygiene condition ($F(2,127) = 17.305, p < .001$). Levene's test for equality of variance was significant ($p < .05$). Therefore, adjustments to degrees of freedom were made. Games-Howell post-hoc comparison indicated that respondents who had bad oral hygiene had a significantly higher UP-Tooth score than both good condition ($p < .01$) and excellent condition ($p < .001$). Those having excellent oral hygiene also had a significantly lower UP-Tooth score than those with good oral hygiene condition.

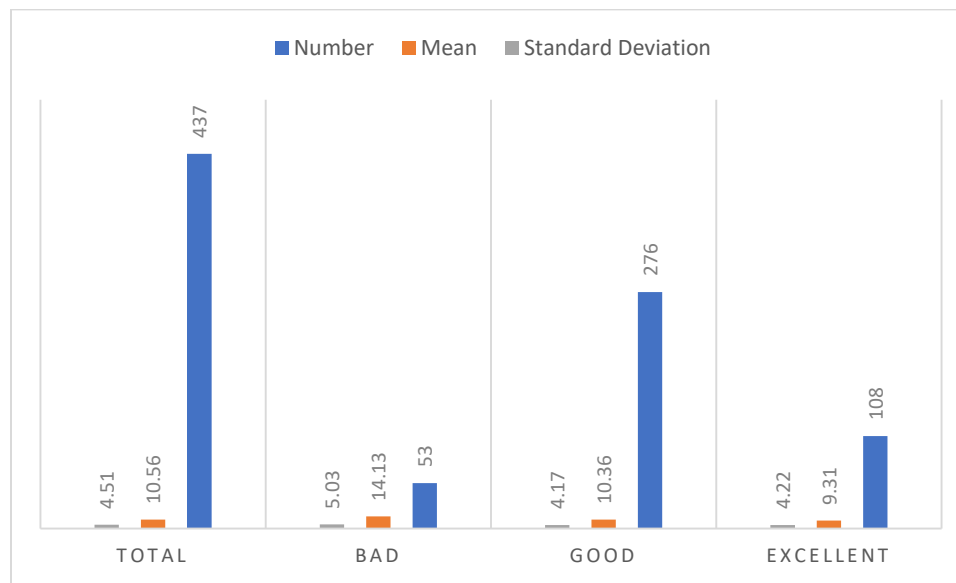


Figure 3 Oral Hygiene and U-Tooth

Table 16 ANOVA between Oral Hygiene and UP-Tooth

Oral Hygiene	N	M	SD	F (2,127)	p-value
Excellent	108	7.16	2.73	17.305	<.001
Good	276	8.63	4.04		
Bad	53	11.21	5.45		
Total	437	8.58	4.12		

Table 17 Games-Howell Post-hoc test between Oral Hygiene and UP-Tooth scores

(I) Oral Hygiene?	(J) Oral Hygiene?	Mean Difference (I-J)	Std. Error	Sig.
Excellent	Good	-1.47	0.36	<.001
	Bad	-4.05	0.79	<.001
Good	Bad	-2.58	0.79	<.01

Table 18, 19 and figure 4 present ANOVA between oral hygiene condition and L-Tooth score is significant ($F(2,125) = 21.457, p < .001$). Levene's test for equality of variance was significant ($p < .05$). Therefore, adjustments to degrees of freedom were made and Games-Howell post-hoc test was conducted. Pairwise comparison showed that respondents having bad oral hygiene had a significantly greater L-Tooth score than both good condition ($p < .001$) and Excellent condition ($p < .001$). Respondents having excellent oral hygiene also had a significantly lower L-Tooth score than those having good oral hygiene ($p < .01$).

Table 18 ANOVA between Oral Hygiene and L-Tooth

Oral Hygiene	N	M	SD	F (2,125)	p-value
Excellent	108	9.00	3.54	21.457	<.001
Good	276	10.53	4.25		
Bad	53	14.28	5.50		
Total	437	10.60	4.51		

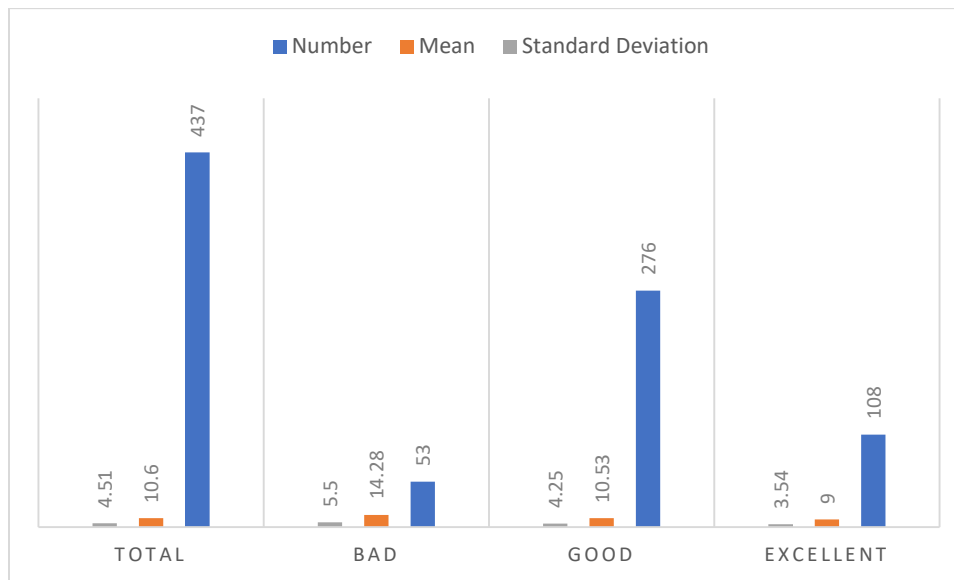


Figure 4 Oral Hygiene and L-Tooth

Table 19 Games-Howell Post-hoc test between Oral Hygiene and L-Tooth scores

(I) Oral Hygiene?	(J) Oral Hygiene?	Mean Difference (I-J)	Std. Error	Sig.
Excellent	Good	-1.53	0.43	<.01
	Bad	-5.28	0.83	<.001
Good	Bad	-3.76	0.80	<.001

Table 20 and 21 present One-way ANOVA test between oral hygiene condition and LP-Tooth score is significant ($F(2,129) = 23.135, p < .001$). Levene's test for equality of variance was significant ($p < .05$). Therefore, adjustments to degrees of freedom were made and Games-Howell post-hoc pairwise comparisons were performed. It indicated that respondents having bad oral hygiene had a significantly higher LP-Tooth score than those who had good oral hygiene ($p < .01$) and those who had excellent oral hygiene ($p < .001$). Respondents having excellent oral hygiene also had a significantly lower LP-Tooth score than those having good oral hygiene ($p < .001$).

Table 20 ANOVA between Oral Hygiene and LP-Tooth

Oral Hygiene	N	M	SD	F (2,129)	p-value
Excellent	108	7.23	2.66	23.135	<.001
Good	276	8.91	4.28		
Bad	53	11.89	5.39		
Total	437	8.86	4.30		

Table 21 Games-Howell Post-hoc test between Oral Hygiene and LP-Tooth scores

(I) Oral Hygiene?	(J) Oral Hygiene?	Mean Difference (I-J)	Std. Error	Sig.
Excellent	Good	-1.68	0.36	<.001
	Bad	-4.66	0.78	<.001
Good	Bad	-2.97	0.78	<.01

4. DISCUSSION

Most overlooked variable in previous studies is the measurement of the severity of stains. The results of our study indicated that smoking does have a negative effect on the oral health. One of the variables that is considered previous studies is the type of smoking, and it indicates the severity of staining caused by different types of smoking on teeth (Bastiaan et al., 1976; Eriksen et al., 1979; Alkhatib et al., 2005; Dalrymple et al., 2018; Zanetti et al., 2019). In the other hand, we found that there are lacks of studies that

talk about electronic cigarettes. One study focused on the effect of electronic cigarettes on teeth color. The result shows that electronic cigarettes can cause perceptible changes on teeth color (Pintado-Palomino et al., 2019).

The results of our study indicated that smokers of traditional cigarettes, electronic cigarettes and hookah had very high tooth staining scores. Meanwhile, respondents taking care of their oral hygiene had low tooth staining scores. Age is considered an important variable that was not covered by the majority of studies. Moreover, one study states that smoking habit and increasing in age were found to be predisposing factors to brown discoloration (Shah et al., 2013). Our study found that participants who are older than 40 years of age had more severe tooth staining than their younger counterparts.

Males were found to be indulged in smoking more than females. Majority of the respondents had started smoking less than 5 years ago. Oral hygiene is one of the most important variables that could affect teeth staining. Discoloration is affected by tooth brushing frequency and technique. Higher frequency of tooth discoloration was noticed among participant who were not brushing their teeth daily (Mohammed et al., 2014). The importance of having excellent oral hygiene is also highlighted in this research as people having excellent oral hygiene also had better oral health compared to those who did not care for their oral hygiene. In order to avoid tooth staining, smoking must be avoided as it clearly affects oral health in a negative way.

5. CONCLUSION

The result of the study showed that males generally had more severe tooth staining than females. Similarly, older people who are 40 years or above in age have more severe tooth staining than younger people. Respondents who had excellent oral hygiene also were found to have a significantly lower tooth staining score than those who had good or bad oral hygiene conditions. Regular smokers of traditional, electric cigarettes and hookah also had high tooth staining scores than non-smokers and occasional smokers.

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Author contribution

All authors contributed to the design, implementation of the study, analysis of the data, and writing the manuscript.

Ethical approval

The research was reviewed and approved under reference #SP20/432/R from the Institutional Review Board (IRB) of the King Abdullah International Medical Research Center (KAIMRC).

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Conflict of Interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are presented in the paper.

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